First Master-Permanentization Solution for Telecommunication Tower

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Abstract. Telecommunications development in Indonesia is growing rapidly, as it is in other emerging countries. With the expansion of this business, there is a very tight level of competition among Indonesian cellular operators as well as in the Tower Provider sector as a provider of supporting infrastructure services. Furthermore, the demand for infrastructure to support telecommunication systems has increased dramatically over the last decade, as the need to erect more towers. As a consequence, these two factors contribute to an increase in the demand for land to build the new tower. Need a solution to take advantage of the existing site, particularly the guyed mast tower, so that no new land is required. The novelty of this paper presents the First Master solution developed by Mitratel, one of Indonesia's largest tower providers. This solution has been used in several locations and proven to use the existing guyed mast tower without turning off the tower transmission to ensure that the telecoms tower can still function.

Keywords: First Master · Solution · Erection · Tower · Telecom

1 Introduction

Telecommunications is still one of the mainstay businesses, especially in developing countries. Over the past three decades, the technology, standards, and development of the Chinese mobile communications industry have gone through a process of introduction, absorption, digestion, and innovation, and it has already become a leader rather than a follower and a pursuer [1]. Economic growth in Sub-Saharan Africa has been increasing over the last two decades [2]. Adela reports some compelling and robust findings which substantiate that ICT has a statistically significant influence on economic growth in Africa [3]. As evidenced by the tremendous construction of telecommunications tower infrastructure. Considering the explosive services demand in cities as a result of population increase, the need for more support structures to be installed [4]. Because of the increasing need for telecom tower construction, developing countries such as Indonesia

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continue to make the telecommunications business a cornerstone. New telecommunication technologies have flooded into Indonesia, within a highly competitive market structure. Local firms such as Telkomsel, Indosat, and Mobile-8 (Smartfren), supported by multinational companies such as Samsung, LG, and Nokia, are now prominent in the market, offering all kinds of discounts on mobile phones and advertising widely [5]. On the other hand, with the growing need for telecommunications infrastructure, there is a limited amount of land available for the building of telecommunications towers. Aside from limited land, there has been an increase in land leasing prices for tower development; the larger the area required, the higher the rent.

However, as building or land permits become more difficult to obtain, aesthetics become increasingly important. Nowadays, it is difficult to find new land to build telecommunications infrastructure, such as towers, so innovation is needed to find new ways to use the existing land and towers while also adding height and new devices. Innovation is complex, uncertain, somewhat disorderly, and subject to changes of many sorts. Innovation is also difficult to measure and demands close coordination of adequate technical knowledge and excellent market judgment to satisfy economic, technological, and other types of constraints – all simultaneously [6]. In this case, related to the telecoms infrastructure, steel is still a commonly used material for steel lattice towers and is typically made from tubular or angular profiles. Steel lattice towers are extensively utilized in the telecommunication industry as supporting structures providing services such as telephoning, wireless internet, or television [7]. Lattice structures for telecommunication purposes are mainly erected in mountainous terrain, where transportation of the building materials can be extremely challenging and costly [8]. When there is a high demand for a specific type of structure, the projects become more unique, with different focus areas from site to site. In addition, because this type of project is now a specialized market, it becomes harder to find real-world experience in terms of both design and execution [9]. Aside from lattice towers, which require specific land, a guyed mast can be used as an alternative solution. Apart from its lightweight, other advantages include the fact that it does not require a significant size of land, the erection time is quicker, and the overall costs are more affordable. Guyed masts have been applied within the field of telecommunications for many years. Previous comparisons of the advantages of guyed masts over self-supporting towers highlight that positive properties of the guyed mast include: lower cost with height, less erection time, and cost-effective foundations [10]. Mitratel, one of Indonesia's largest tower providers provides the solution, to how to use the existing guyed mast structure with minimize strengthening to add more antennas and other ancillaries is called First Master. This solution has been used in several locations and proven to use the existing guyed mast tower without turning off the tower transmission to ensure that the telecoms tower can still function.

2 Background

Telecommunications development in Indonesia is growing rapidly, as it is in other emerging countries. With the expansion of this business, there is a very tight level of competition among Indonesian cellular operators as well as in the Tower Provider sector as a provider of supporting infrastructure services. Furthermore, the demand for infrastructure to support telecommunication systems has increased dramatically over the last decade, as the

need to erect more towers. As a consequence, these two factors contribute to an increase in the demand for land to build the new tower. Nowadays, it is difficult to find new land to build telecommunications infrastructure, such as towers, so innovation is needed to find new ways to use the existing land and towers while also adding height and new devices. Need a solution to take advantage of the existing site, particularly the guyed mast tower, so that no new land is required. Mitratel has the largest tower portfolio in Indonesia spread across strategic locations. Of 35,051 towers, less than 2% or 724 sites are guyed mast structures. Guyed masts are common structures to support telecommunication devices used worldwide. They are slender and light structures frequently exposed to high winds which are determinant loads in their structural design [11]. Guyed masts are telecom towers that have guy wires, which are tensioned cables used to stabilize the tower [12]. Guyed masts are extensively used in the telecommunications industry, and the size, shape, and topology optimization can significantly benefit their transportation and installation [13]. The analysis and design of masts and towers require specific knowledge and expertise, particularly concerning guyed masts. Towers are lightweight structures with high slenderness and high flexibility [11]. This paper presents a solution regarding the use of existing towers especially guyed masts to support demand from operators with additional equipment.

3 Methodology

Used of existing guyed mast structure becomes the main object in this study. The concept of the First Master solution is to keep using the existing guyed mast by modifying by replacing the guyed wire and covering it with steel angle. The purpose of using this steel angle is to ensure that the guyed mast structure can still accept force from either the existing load or an additional load. The guyed mast structure used is 42 m tall, with the following material list below (Table 1):

Table 1. Material List of Guyed Mast.

Member	Material	Dimension	Unit
Horisontal	Roundbar	φ 19	mm
Bracing	Roundbar	φ 19 and φ 16	mm
Leg	Pipe	1	inch

Source: Detail Drawing [14].

Furthermore, to obtain the most efficient tonnage from the use of steel angle, an analysis was performed using the MS Tower version 222 G and this program can be used for linear and non-linear analysis, static and dynamic analysis of communication and transmission towers [15–17]. Standard drawing and drawing modification for the guyed mast is presented below,

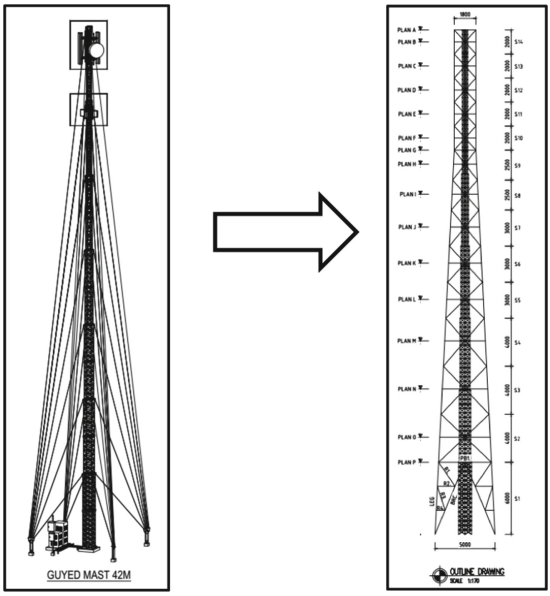

Fig. 1. Existing Guyed Mast. Modification Guyed Mast

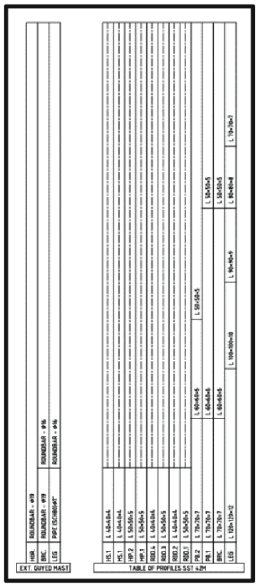

Fig. 2. Outline Drawing

Figure 1 show the original Guyed Mast modification, the modifications include removing the guy wire and replacing it with a steel angle, popularly known as Self Supporting Tower (SST) [18]. Figure 2 shows the material list for Guyed Mast and the modification or SST. Figure 3 presented a view of the guyed mast including detail of the connection. Before undertaking a guyed mast modification with SST, make sure the guy wire is tight [19]. To keep the guy wire, a Helical pile will be installed immediately, this function as a temporary foundation to attach those guy wire to it [19]. Helical piles are now widely used in many fields, both onshore and offshore, and have proven to be very useful and efficient. Large diameter piles at cohesive and cohesionless sites in western Canada using three-helix were successfully implemented [20]**.** Helical piles are used mainly to resist tension forces generated by uplift and overturning moments of various structures, therefore they have been suggested as a potential alternative to driven piles as offshore piles because they provide a large uplift capacity due to the anchor effect of the helix [20]. M. Muthukumar and Sanjay Kumar Shukla also did deep research regarding the use of Helical piles in expansive soil [21]. Tests were carried out on helical pile foundations where there were similarities between helical collisions and pile collisions [22].

To get a better understanding, will explain how the Helical pile is used to support this solution.

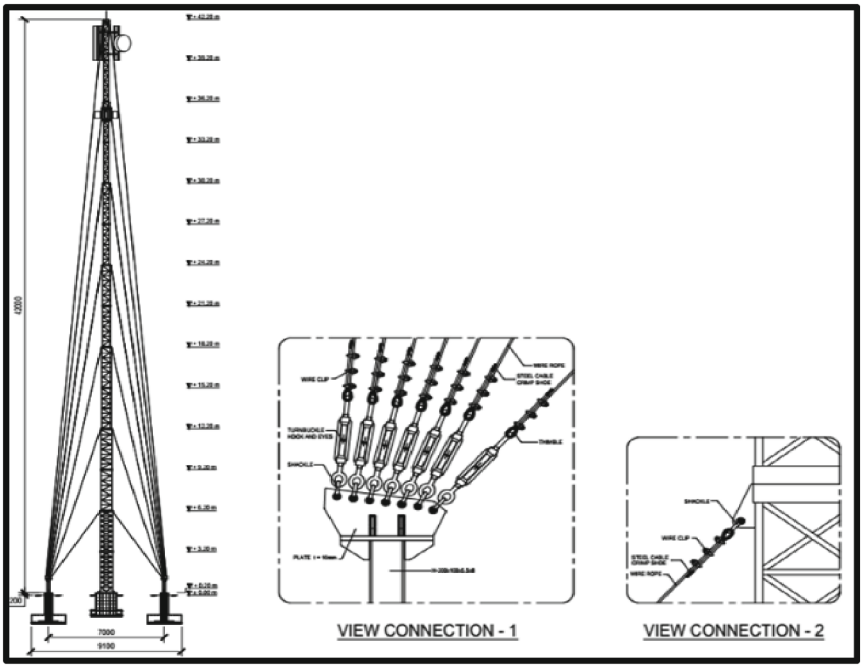

Fig. 3. Guyed Mast view.

Figures 4 and 5 show the Guyed mast 42 m high view and section which will be permanently modified into SST 42 m using the existing guyed mast. Figure 6 presented a strengthening plan using a Helical pile to keep the Guyed mast still standing during the transformation from Guyed mast to SST.

The general process regarding the First master is already described in the paragraph above, furthermore, the picture below will present all processes or activities starting from beginning until finish. Starting from the fabrication process, site opening, using Helical pile, pouring concrete for a new foundation, tower installation, and finally equipment installation on the existing Guyed mast site without dismantling and shutting down the power (Fig. 7).

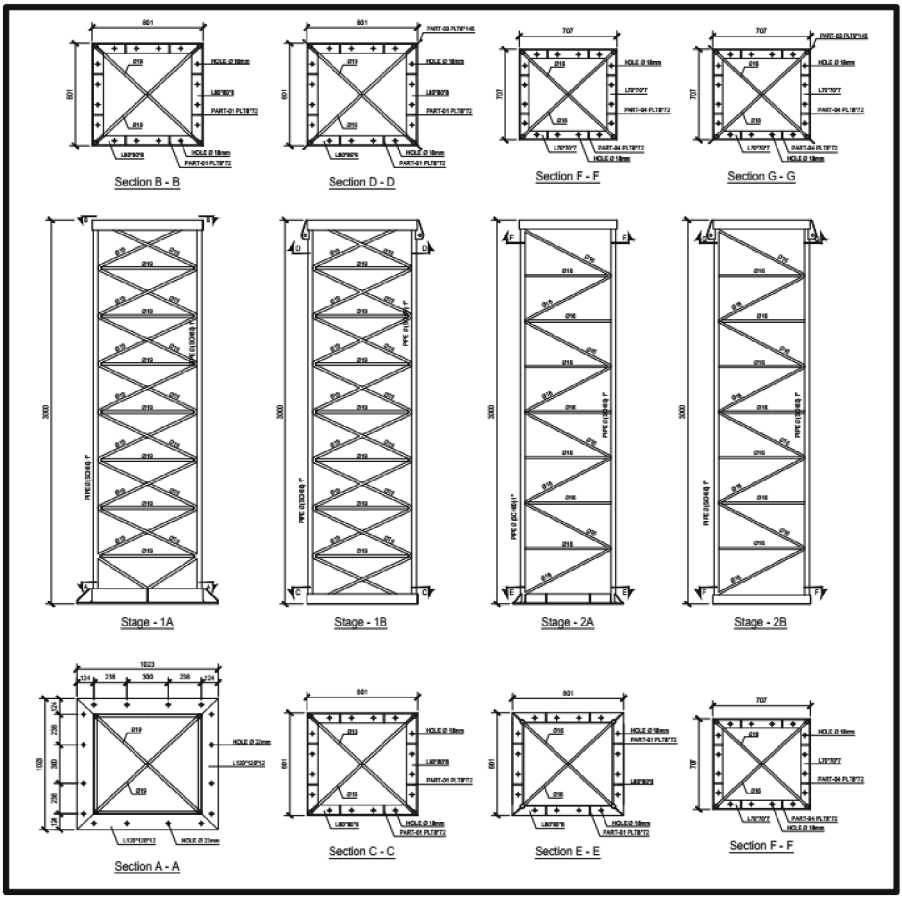

Fig. 4. Guyed Mast section.

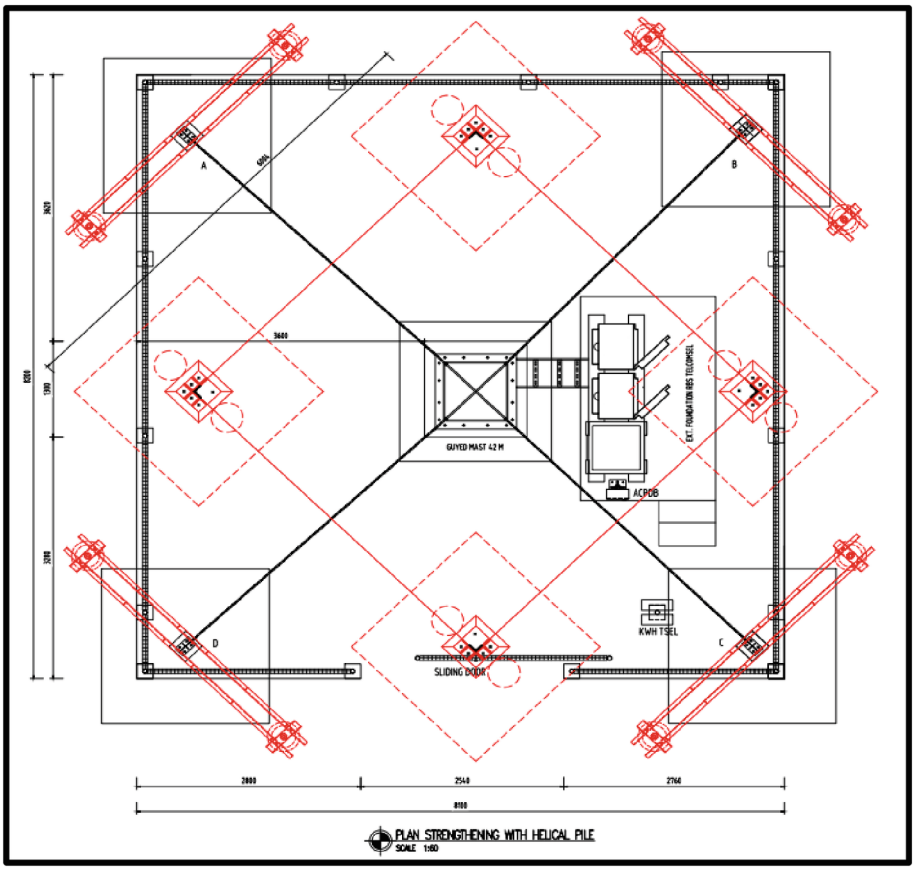

Fig. 5. Strengthening plan with Helical pile [23, 24]

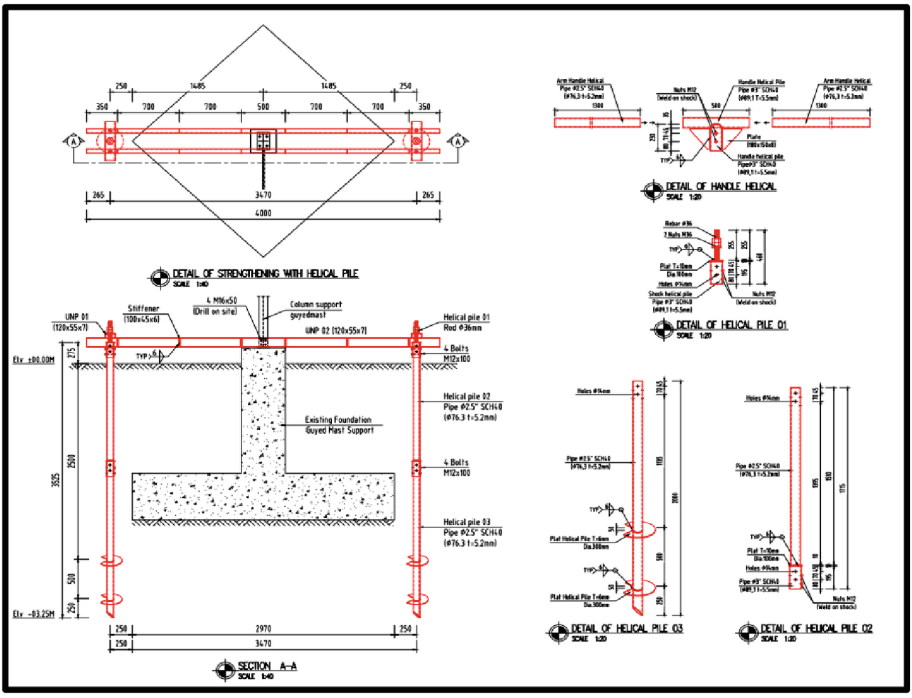

Fig. 6. Detail of Helical Pile [23, 24]

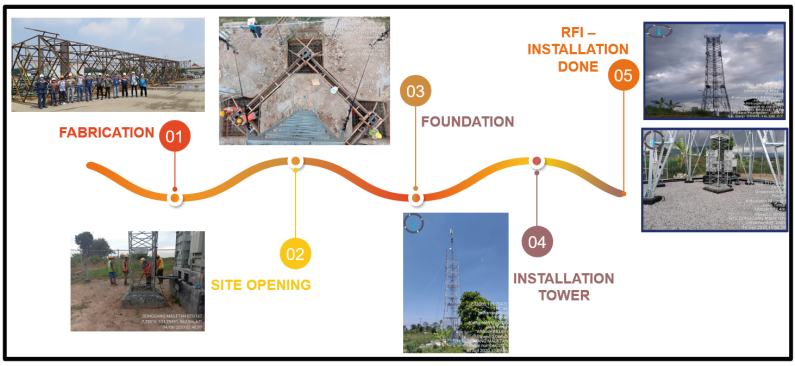

Fig. 7. The first Master construction process is on-site [25].

4 Conclusion

The first master staging consists of the following milestones as shown in the Table below (Table 2):

Table 2. First master Stages.

First period	Second period	Third period
Guyed mast Permanenization planning Overload and over quota database for Guyed mast tower	Review and design selection Approval for design Tower first master mockup	Tower's first master fabrication Delivery to site Tower implementation

Each of the milestones completed shows that there is a difference in duration/time between the first master and the standard process. In general, the first master approach is 24 days faster than the conventional method (Built to Suite or B2S). The following figure shows the time difference between First Master and the typical B2S method (Fig. 8):

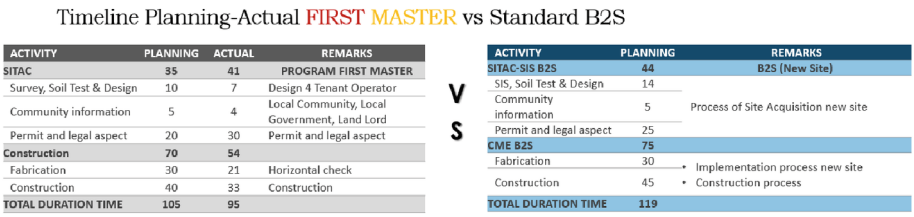

Fig. 8. Time Planning Actual First Master vs Standard [25]

Aside from the reduced time duration, the other benefits of the First Master solution are described in the figure below (Fig. 9).

NO	Scope of Work	FIRST MASTER	STANDARD TOWER (SST 4 LEG/ 3LEG)
1	Land lease for support Combat (Max 3 month)	No Need	Need
2	Combat	No Need	Need
3	Dismantle Equipment	• No Need • Equipment On at Tower GM-Existing	• Need
4	Dismantle Tower	No Need	Need – New Tower installation
5	Dismantle Sling	• No Need	Need – New Tower installation
6	SACME	Need	Need
7	RFI-On Air Equipment	Easy to move the equipment directly	Equipment move after Erection Tower (RFI) done
8	Structural point of view	• From Guyed Mast to 4 Leg tower • Design calculation suitable for tenant capacity or existing Load	• Standard Tower SST (4 Leg-3 Leg) • Design calculation base on type of tower (New Light, Light, Medium, Back Bone)
9	Pro - Contra	• No turn off equipment • No new land • Easy to move existing equipment • Structural design more flexible and suitable for existing load	•Turn off equipment •Tower existing mandatory to dismantle • New land • Structural design refer to standard design
10	Equipment	• 4 Tenant : - Ø 1.2 MW (8 Pcs) - 2.580 x 0.260 x 0.120 Antenna Sector (12 Pcs) - 0.550 x 0.550 x 0.150 RRU (24 Pcs)	• 2 Tenant (6RF + 6RRU + 2MW 0.6m + 1MW 1,2m)

Fig. 9. First Master Pro Cont [25].

We realize that the first master is not ideally yet; further improvements are required to ensure that this solution is truly the best answer in terms of implementation method, cost, and time.

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